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Evidence of hillslope connectivity on Aleppo pine plantation by artificial stemflow experiments and preferential flow pathways detection using time-lapse ground penetrating radar surveys

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The hydrological response of steep slopes catchments is strongly conditioned by the connectivity of subsurface preferential flows. The objective of this research is to investigate the role played by stemflow infiltration in subsurface water flow dynamics, focusing on a forested hillslope located in an Aleppo pine Mediterranean forest (Pinus halepensis, Mill.) located at Sierra Calderona, Valencia province, Spain. We combined stemflow artificial experiments with ground-penetrating radar (GPR) techniques as a non-invasive method to investigate stemflow-induced preferential flow paths activated by different trees and the related hydrological connectivity at the hillslope scale. Our observations allowed us to identify different dynamics associated with the initiation of stemflow and then lateral preferential flow, including the activation of connected preferential flow paths in soils that received stemflow water from different trees. These observations provided empirical evidence of the role of stemflow in the formation of lateral preferential flow networks. Our measurements allow estimations of flow velocities and new insight on the magnitude of stem-induced lateral preferential flow paths. The applied protocol offers a simple, repeatable and non-invasive way to conceptualize hillslope responses to rainstorms.